culture, the cells growing more rapidly in contact with atmospheric oxygen than when submerged.

5. While this appears to be the chief factor, other elements such as better conditions of nutrition, etc., probably enter in as less important factors.

These researches were carried on in the biological laboratories of the University of Wisconsin.

Baltimore, Md.

Noteworthy anatomical and physiological researches.

Apical areas in seed plants.

The copious researches of MM. Van Tieghem and Douliot[1] on the origin of endogenous members in the vascular plants, published in the *Annales des Sciences Naturelles Botanique* during 1888, will be remembered by all students of contemporary botanical literature. The conclusions arrived at regarding the apical cells of monocotyledons and the single apical cell of the Archispermæ (gymosperms) are well known, having already found their way into at least one of the more prominent text-books. It is by no means universally admitted, however, that the proof of apical cells in these groups of plants is decisive. The older literature on the subject was given in résumé by Dingler[2] in 1882, but since that time the important works of Karsten,[3] DeKlercher,[4] Groom,[5] Korschelt,[6] and others have appeared, supplementing the classic researches of Strasburger, Hanstein, Hofmeister, and the rest. In the *Ann. des Sciences Nat. Botanique*, 1890, Douliot[7] reviews the later works and, adding some investigations of his own, maintains the positions advanced in 1888 in his paper in conjunction with Van Tieghem. In brief, his conclusions are as follows:

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[1] Recherches comparatives sur l'origines des membres endogènes, Ann. Sci. Nat. Botan., VII. VIII. 1. (1888.)

[2] Ueber das Scheitelwachsthum des Gymnospermen-Stammes, München, 1882.

[3] Ueber die Anlage seitlicher Organe bei den Pflanzen, Leipzig, 1886.

[4] Sur l'anatomie et le développement du Ceratophyllum, Bihang, k. Sv. Vet. Acad. Hand. IX, Stockholm, 1885.

[5] Ueber den Vegetationspunkt der Phanerogamen, Ber. der deutsch. bot. Gesell. 1885.

[6] Zur Frage über das Scheitelwachsthums bei den Phanerogamen, Pringsh. Jahrb wiss. Bot. 1884.

[7] Sur la croissance terminale de la tige, Ann. Sci. Nat. Botan. VII, XI. 283.

(1). In the twenty genera of gymnosperms which have been studied the uniform presence of a single apical cell at the summit of the growing stem has been demonstrated. This cell, as in the lower vascular Archegoniata, is sometimes pyramidal, sometimes prismatic, but always solitary. Here is the diagnostic anatomical character of the Gymnospermæ. They are, by it alone, sharply discriminated from the rest of the seed-plant phylum.

(2). In the monocotyledons there are two categories to be distinguished; first where there are three initial cells at the apex of the stem from which all the others are derived, as in Phragmites, Tradescantia, Zea, Asparagus, Polygonatum, Canna and others; and second, where there are but two, as in the Naiadaceæ, Potamogetonaceæ, Juncaceæ, Alismaceæ and Hydrocharidaceæ. The latter case is the more frequent.

(3). In the great majority of the dicotyledons the stem is terminated by three apical or initial cells. In a small number, principally in the the apetalous division of the Archichlamydeæ, there are only two initials, and in this case one initial cell is common to the dermatogen and plerome layers of Hanstein, but in the other and more common case each embryonic layer has its own peculiar initial cell. In the Gamopetalæ (Metachlamydeæ) there are three initials, so far as the investigations have gone.

It is thus seen that, in addition to a clearly functional archegonium or egg-organ, the Archispermæ (Gymnospermæ) are distinguished from the Metaspermæ (Angiospermæ) by the presence of a single apical cell. Thus evidence seems to be accumulating in favor of the classification, long ago proposed, which would include the Coniferæ, Cycadeæ and Gnetaceæ with the Pteridophyta, Bryophyta and Characeæ (and possibly the Coleochaeteæ) under the Archegoniatæ—those plants with a functional egg-organ. The Metaspermæ are sharply distinguished by the abortion of the egg-organ while the Thallophyta are as clearly discriminated by the absence or rudimentary condition of the egg-organ. In addition to these characters the Metaspermæ are the only plants which develop their epidermis independently from a definite proto-epidermal meristem cell. This character seems to be an important one from a phylogenetic point of view and gives color to any plan which proposes to recognise the great affinity between the heterosporous Filicneæ and Lycopodineæ, re-

spectively, and the Cycadeæ and Coniferæ. In this connection one can not but deplore that in some quarters American botany has not yet freed itself from the altogether obsolete notion that the Coniferæ should be placed between the monocotyledons and the dicotyledons. — CONWAY MACMILLAN.

Effects of parasitism of Ustilago antherarum Fries.[1]

Ustilago antherarum is included by Saccardo[2] under *U. violacea* (Pers.) Fckl. and is well known as parasitic in the anthers and ovaries of Silene, Lychnis, Saponaria, Pinguicula, Stellaria and other allied plants. By the growth of the fungus, what has been termed by A. Giard "parasitic castration of the anthers" takes place. There is, however, a hypertrophic development of the anther and in the diclinous flowers of Lychnis, which have in common with other such flowers rudiments of the undeveloped sporangia — this hypertrophy suffices to give the flower a monoclinous appearance. Under the irritation of the parasite the rudimentary anthers in pistillate Lychnis flowers are stimulated to develop, but the tapetal and archesporial layers of the thecæ are supplanted by the fungus mycelium and subsequent growth of spores. For a considerable time the Ustilago plant develops by a kind of symbiosis with the cells of the host. This goes so far that the anther walls are, in normally pistillate Lychnis flowers, stimulated to form the typical layers by which the ordinary dehiscence is brought about. Thus the Ustilago spores are scattered from the hypertrophic anthers of Lychnis precisely as if they were normal pollen spores. A corresponding and attendant atrophy of the pistil will be observed in most cases, and it is the nutritive stream which properly should go toward the pistil, that is diverted toward the hypertrophic anthers. And furthermore the various accessory characters of the staminate flower are developed in proper order under this parasitic stimulation, so that the normally pistillate but apparently staminate flower presents the appearance of pollen-bearing to such an extent that it is doubtless visited by those insects which habitually transfer pollen from the staminate flower to the stigma of the pistillate. Now as the Ustilago spores are developed in lieu of pollen spores and make their

[1] Vuillemin: Sur les effets du parasitism de l'Ustilago antherarum, Comptes Rendus Hebd. CXIII. 662. (1891.)

[2] Sylloge Fungorum VII. 574.